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Preliminary Experiments in Spraying to Kill the San José Scale-Insect. Season of 1901.

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PRELIMINARY EXPERIMENTS IN SPRAYING TO KILL THE SAN JOSÉ SCALE-INSECT. SEASON OF 1901.

By W. E. Britton, *State Entomologist.*

The contradictory results obtained by different experimenters, even within the limits of a single State, regarding the effect on trees of crude petroleum and kerosene, indicate that these materials should be tested in each locality before we can wisely recommend their use. It is certain that trees have been injured and even killed by applications of these oils, while in hundreds of other cases no injury could be detected. It is quite probable that climatic influences, such as temperature, humidity, altitude, exposure, etc., may be responsible for the varying results. To study some of these points as well as to note the effects on the insect, careful tests were made the past season in three different localities, all situated near the coast.

In each of the experiments at Westville, Stratford, and East Haven, the twigs were examined before insecticides were applied, and the percentages of living scales noted. A month or six weeks after spraying, twigs were again taken from these trees and the percentages of living scales again determined, thus giving some idea of the effect of the treatment upon them. It is not claimed that the percentages exactly represent the conditions of the insects on the whole tree in each case, as it is difficult to obtain twigs that can fairly stand for all conditions of exposure, etc., to which the tree is subjected. On some twigs the scales were nearly all dead, while on others most of them were alive. As a number of twigs were selected in each case and as judgment was used in making this selection, it is believed that the average figures are approximately correct, and show the results of the treatment much more accurately than any mere estimate not based upon actual enumerations.

The kerosene used was taken from a barrel purchased for illuminating purposes, branded "Devoe's Brilliant Oil," and claimed to have a fire test of 150°.

The crude oil was obtained from the Standard Oil Co. and

shipped to us from Providence, R. I., after being ordered from Philadelphia, Pa., according to arrangements made by Professor J. B. Smith of New Jersey. This oil had a specific gravity of very nearly 43° Beaumé. Anyone desiring crude oil for insecticide purposes, may obtain it from Mr. P. M. Watt, Manager, Providence Department, Standard Oil Co., 136 South Water St., Providence, R. I., and it should be ordered as "Insecticide Oil."

The soap used in these tests was the "Welcome," a brand in common laundry use. Any similar hard soap would doubtless answer the purpose quite as well.

The Babbitt's lye was the commercial product put up in tin cans for household use and labeled "Babbitt's Potash or Lye." It consists of soda, however, instead of potash.

The extensive orchard work, both at Westville and Stratford, was done with the "Kerowater" barrel pump made by the Goulds Mfg. Co., Seneca Falls, N. Y.

In the more careful tests, where only a few trees were sprayed, the "Success" bucket pump was used. This pump is manufactured by the Deming Co., Salem, Ohio.

WESTVILLE EXPERIMENTS.

The first experiments were conducted on dormant trees at Westville. The applications were made on April 12th, which was a bright day with a moderate breeze. The materials used were: 1, kerosene and water in mechanical mixtures (containing 15 and 20 per cent. of kerosene), 2, crude oil, and 3, Babbitt's lye—one pound to four gallons of water. With the exception of a peach tree sprayed with crude oil, all the trees were drenched, great care being taken to cover every portion of the bark.

These tests on a few trees were made by the writer with the greatest care. The owner sprayed his entire orchard, using the 20 per cent. mixture of kerosene and water on most of the trees, and a 25 per cent. mixture on the remainder.

Plate I (*b*) shows the appearance in July of a peach tree sprayed with crude oil, and (*a*) shows at the same time a tree sprayed with 20 per cent. kerosene in water. Both trees were sprayed on April 12th.

Table I shows the number and kinds of trees treated, materials applied, what percentage of the total number of scale-insects found on the twigs were living at the time they were examined, condition of trees at time of application, and the percentage of insects found alive after the application, percentage probably killed by the treatment, and the effect of the treatment upon the foliage, etc.

By consulting the table, the reader will see that in case of the pear tree drenched with the crude oil less than one per cent. of living insects was found when examined on July 3d. This may be somewhat misleading, but it should be remembered that the figures represent only a single tree. The percentage of living insects was even lower (.043 per cent.) on one of the pear trees treated with the kerosene and water mixture having 20 per cent. of kerosene, though the average of the three trees was much higher (3.07 per cent.). The results also indicate that 15 per cent. of kerosene in the kerosene and water mixture is fatal to most of the scales at this time of the year and under these conditions. Crude oil does not evaporate as readily as kerosene and remains on the bark for several months, thus preventing many young scales from becoming established.

Babbitt's lye of the strength used, and on the single pear tree, was less effective in destroying the scales than crude oil or the kerosene and water mixture containing 20 per cent. of kerosene.

Experiments at Stratford.

After the foliage appeared, an orchard in Stratford was found to be infested with scales, and experiments were made there, to note the effect of the insecticides upon both the foliage and insects. Spraying was done on June 19th, in pleasant weather. The application used consisted of 15 per cent. kerosene in water on a large number of trees. On a single tree each, mixtures of crude oil and water containing 30, 20, and 15 per cent. of crude oil were used. The entire orchard, containing over three hundred trees, was sprayed, more than two-thirds (220 trees) with 15 per cent. of kerosene in water, and the remainder (85 trees) with 15 per cent. of crude oil in water, the trunks and bases of the branches being covered with the insecticide, but care was taken that it should not reach the foliage.

TABLE I.—WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 12TH, 1901.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on June 3d.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined June 3d.
1	Peach.	Badly infested	No treatment	.76	83.6	0	
1	"	Moderately infested	15 per cent. kerosene in water.	79.8	8.4	71.4	No perceptible effect.
3	"	" "	20 " " " " "	84.3*	5.8*	78.5*	" " "
1	"	Slightly infested.....	Crude oil. Surface of trunk and branches moistened ..	80	5.4	74.6	No injury.
1	Pear.	Moderately infested	15 per cent. kerosene in water.	82	3.9	78.1	" "
3	"	" "	20 " " " " "	81*	3.07*	78*	" "
1	"	Badly infested	Crude oil. Tree drenched...	83	.1	82.9	Injury very slight. A few buds were destroyed.
1	"	Moderately infested	Babbitt's lye. 1 lb. to 4 gal. water.....	85	12.6	72.4	No injury.
1	Crab-apple.	Badly infested	20 per cent. kerosene in water.	89.3	8.7	80.6	" "

* These figures represent the average percentages from three trees.

At this time the first brood of scales had not appeared.

From an examination of Table II, it may be seen that the various mixtures of crude oil with water caused injury to the foliage and fruit, to such an extent as to prohibit its use on peach trees in leaf, though it must be admitted that it was rather more effective in killing the insects than the kerosene and water mixtures. The soap and water injured the foliage about as badly as crude oil and water. The kerosene and water mixture, containing 15 per cent. of kerosene, caused practically no injury on peach trees in foliage.

East Haven Experiments.

The third series of experiments was carried out at East Haven on trees in foliage, June 26th. 15 and 10 per cent. of kerosene mixed with water, and the same proportions of crude oil and water, and the soap solution (one pound of soap to eight gallons of water) were used. The next day after applying these insecticides (June 27th), the young insects began to appear, not having been seriously injured before birth by the applications.

The tests at East Haven (see Table III) gave results very similar to those obtained at Stratford as regards the effect of kerosene and crude oil mixtures on both the San José scale insect and the peach trees. Soap and water injured the leaves as much as crude oil, though less destructive to the scale.

Other Records.

A purple-leaved plum tree, growing in New Haven and badly infested with the scale, was treated on July 24th with a kerosene and water mixture containing 15 per cent. of kerosene. The weather was fair with a moderate breeze. The treatment was very thorough, and the mixture made to cover every portion of the tree until it dripped from the branches. On August 28th, twigs were cut from the tree to ascertain the effect of the treatment. Of three hundred and eight (308) individuals examined, only three were alive. The tree shed a few leaves but did not appear to be damaged to any serious extent.

During the latter part of the Winter, currant twigs received from Bridgeport were found to be infested with the San José

TABLE II.—STRATFORD EXPERIMENTS. TREES IN FOLIAGE, SPRAYED JUNE 19TH, 1901.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on July 9th.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined July 9th.
2	Peach.	1 badly infested; 1 not infested	15 per cent. kerosene in water. Entire tree drenched.	Not taken.	Not taken.	Not taken.	A few leaves and young fruits dropped. Practically no injury.
3	"	Badly infested.....	15 per cent. kerosene in water. Entire tree drenched.	91.4	33.3	58.1	A few leaves and young fruits dropped. Practically no injury.
1	"	" "	15 per cent. crude oil in water. Entire tree drenched.	88.6	24	64.6	Caused injury to lower leaves, fruits and a few tender shoots.
1	"	" "	20 per cent. crude oil in water. Entire tree drenched.	87.5	11	76.5	Took off most of the foliage. New leaves are putting out.
1	"	Badly infested. Entire top had been cut off and only trunk and new shoots remained.	30 per cent. crude oil in water. Entire tree drenched.	Not taken. Nearly all dead on twig examined.	Not taken.	Not taken.	Tree severely injured.
3	"	Badly infested.....	1 lb. soap in 8 gal. water. Entire tree drenched.	80.8	27	53.8	Severe injury. Nearly all the fruit spoiled and lower leaves gone. New shoots killed. Only leaves on topmost branches remain.
220	"	Moderately infested	Trunk and branches (not the foliage) sprayed with 15 per cent. kerosene in water.	Not taken.	Not taken.	Not taken.	Practically no injury. A few leaves dropped.
85	"	Moderately infested	Trunk and branches (not the foliage) sprayed with 15 per cent. crude oil in water.	Not taken.	Not taken.	Not taken.	Some injury. Leaves and young fruit were killed where the spray came in contact with them.

scale. The owner sprayed his plants carefully, on March 12th, using a soap emulsion of kerosene containing 25 per cent. of kerosene. The weather was fair, and in most cases the twigs were so covered that the emulsion dripped from them. Fifteen gallons of the mixture covered five hundred currant bushes, and was applied with a Garfield knapsack sprayer. Twigs were examined at the Station, on May 22d, and it was found that less than one per cent. of the scale-insects were alive.

This form of treatment does not require the special pump for mixing kerosene and water, but the emulsion may be applied with any spray pump.

Effect on Trees.

The peach leaves were somewhat injured by the insecticides. It is known that peach foliage is very susceptible to most spraying mixtures, and that Bordeaux mixture, which is commonly used on the foliage of most fruit trees, cannot be used safely upon peach trees in this climate. Crude oil in all the percentages used caused injury, though the 15 per cent. mixture was scarcely more injurious than the mixture containing 10 per cent. of oil.

The soap and water caused as much injury as the crude oil, but was not as effective in killing the scales. Leaves injured by the applications became ragged and perforated, portions of the tissue being killed and falling away, much resembling those attacked by the shot-hole fungus. These leaves turned red and dropped later. In some cases the young fruits were killed by the application, and these shriveled and afterwards dropped; the young twigs were also killed but the hardened growth remained uninjured. At first it was thought that the kerosene and water mixtures had caused injury, but only a few leaves dropped and it is doubtful if the trees were really injured at all; much less so, unquestionably, than would be the case were the scales allowed to multiply unchecked.

We are not yet able to make any statement regarding the effect on trees of repeated applications of kerosene or other mineral oils. Further experience is necessary to determine this point. Thus far, however, it seems fairly safe to apply kerosene and water in a 15 per cent. mixture to fruit trees in foliage, and

TABLE III.—EAST HAVEN EXPERIMENTS. TREES IN FOLIAGE, SPRAYED JUNE 26TH.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on Aug. 2d.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined July 3d.
2	Peach.	Partly dead. Badly infested.	15 per cent. kerosene in water	72.7	28	44.7	Injury very slight; not worth considering.
2	"	1 partly dead, badly infested, 1 in good condition, moderately infested.....	10 " " "	82	34	48	No perceptible injury.
2	"	1 unthrifty with "yellows," 1 quite vigorous, both moderately infested	15 Crude oil in water	76.7	23	53.7	A few tender shoots, leaves and young peaches killed.
2	"	Quite vigorous. Moderately infested	10 " " "	83.5	20	63.5	Slight injury to new growth leaves and fruit.
2	"	1 partly dead, badly infested. 1 in fair condition, moderately infested.....	1 lb. soap in 8 gals. water....	86.5	73	13.5	This application seemed to injure foliage and fruit as much as 15 per cent. crude oil in water.

our experience indicates that the scale may be held in check to a considerable extent by so doing, especially if the application be made after the breeding season of the insect begins, or during the latter part of the Summer.

We were not able to detect any considerable injury to the dormant trees by any of the insecticides applied just before the buds opened in the Spring.

Effect of the Treatment upon the Scale-Insect.

It may be seen from the tables that both the crude oil and 20 per cent. kerosene mixture were effective in destroying the scale when applied to dormant trees late in the Spring. The same materials did not kill the scales as satisfactorily when applied in June. We are unable to give a reason for this, but it may be due to the condition of the insects, which at the time of spraying in April were mostly females, nearly mature, and about ready to give birth to their young. In both cases, at East Haven and Stratford, the treatment killed a much smaller percentage of the insects than similar applications to dormant trees in April, or to trees in foliage during the latter part of July. Had the spraying been done a few days later, and when the young were crawling, it would unquestionably have killed nearly all the young scales, and even the spraying late in July was very effective in destroying both the young and mature insects.

Summary.

(1) Contradictory results regarding the effect of mineral oils on trees rendered it essential that tests be made in each locality before the use of such oils be recommended. Such experiments have been conducted the past season in three localities near the coast.

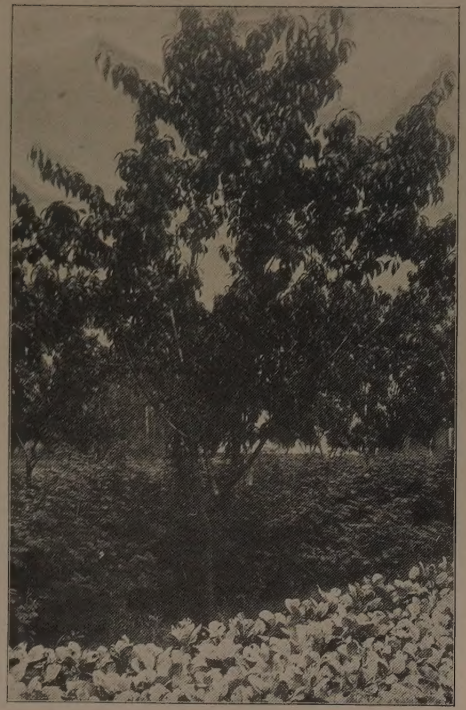
(2) Twigs were taken from each tree and the insects examined before treatment; another examination was made a month or six weeks later and percentage of living insects noted in each case to determine the effect of the treatment.

(3) Crude oil, kerosene and water, with 15 and 20 per cent. of kerosene, and Babbitt's lye, one pound to four gallons, was used on dormant trees at Westville just before the leaves appeared in Spring. Kerosene and water mixtures, and crude oil and water mixtures, that contained oil in proportions from 10 to 30 per cent., and soap and water (one pound of soap to eight gallons of water), were used on peach trees in foliage at Stratford and East Haven.

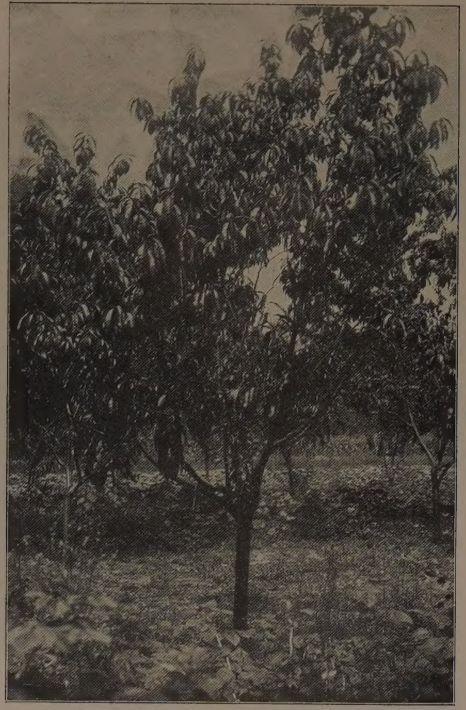
(4) Crude oil having a specific gravity of 43° Beaumé, and a kerosene and water mixture containing 20 per cent. of kerosene, were both effective in destroying the San José scale where applied to dormant trees just before growth started, and did no apparent harm to the trees. Babbitt's lye in the strength used was much less effective.

(5) The scale may be held in check on peach trees in foliage by spraying with kerosene and water mixture containing 15 per cent. of kerosene without serious injury to the trees, but was not as effective in destroying the scale when applied during the latter part of June as when applied a month later. 15 and 10 per cent. of crude oil mixed with water caused injury to peach foliage and is not to be recommended: the same may be said of common soap and water (one pound to eight gallons).

(6) Kerosene emulsion containing 25 per cent. of kerosene is effective in destroying scales on dormant trees and may be applied with any form of spray pump.



(*a*) Peach Tree sprayed April 12th, with a mechanical mixture of kerosene and water, containing 20 per cent. of kerosene. (Photograph taken in July.)



(*b*) Peach Tree sprayed April 12th with crude petroleum. (Photograph taken in July.)